Platform Machining Evaluation

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Air Methods
Englewood, Co.

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14. ABSTRACT

Air Methods Corporation, Englewood, CO, manufactures litter pans (platforms) used in the UH-60Q MEDEVAC (Medical Evacuation) variant of the UH-60 Black Hawk interior that are machined aluminum pieces designed to support litter-borne patients. These platforms also serve as attachment points for the ambulatory patient seats. The original platforms were designed to meet civil crash requirements. However, with the pending introduction of the HH-60M, the platforms must meet stricter Army crash requirements, and the loads on the platforms themselves have increased. Air Methods Corporation requested that the National Center for Defense Manufacturing and Machining (NCDMM) review a proposed stiffener design and develop a manufacturing process capable of producing a complex stiffener geometry that will reduce the weight of the platform along with increasing its "payload" capacity.

15. SUBJECT TERMS
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Air Methods
Platform machining Evaluation

Prepared by: Doug Perillo

Executive Summary

In 1996, the US Army began fielding the UH-60Q MEDEVAC (Medical Evacuation) variant of the UH-60 Black Hawk. The MEDEVAC variant fielding has continued in low-rate production since the HH-60L variant, but has remained unchanged since its initial design. With the introduction of the UH-60M into the Army's fleet, the MEDEVAC fleet must keep pace to meet the requirements of Aviation Transformation. With the pending introduction of the new HH-60M version, the Army is faced with the conflicting goals of reducing system weight and unit cost while simultaneously meeting tougher crash loading standards for the patient care systems.

The litter pans (platforms) used in the MEDEVAC interior are machined aluminum pieces designed to support a litter-borne patient during a crash, and to also serve as an attachment point for the ambulatory patient seats. The original platforms were designed to meet civil crash requirements. However, for the HH-60M, the platforms must meet stricter Army crash requirements, and the loads on the platforms themselves have increased. The contractor has proposed increasing the structural strength of the platforms by increasing the web thickness on the underside, but this improvement comes at a penalty of increased weight.

Reducing the weight of the Medical Interior increases the performance margin on the aircraft. This translates into increased "payload" capacity, better performance, better fuel efficiency, and longer aircraft life.

Therefore, Air Methods has requested that the National Center for Defense Manufacturing and Machining (NCDMM) review proposed stiffener designs and develop a manufacturing process capable of producing a complex stiffener geometry that will reduce the weight of the platform along with increasing its “payload” capacity.

Project Details

Air Methods along with the NCDMM engineers reviewed several improved strength stiffener designs. Air Methods decided on a design that would increase the bottom face contact surface of the platform. It is believed that this increased platform surface will satisfy the demand for the increased load on the UH-60Q Platform. The new design allowed for a 50% increase on the contact surface. The old design, consisting of a straight wall, will be replaced with an under cut wall with both the bottom and the top of the wall having radii to strengthen and blend to the wider surface, see Figure #1.

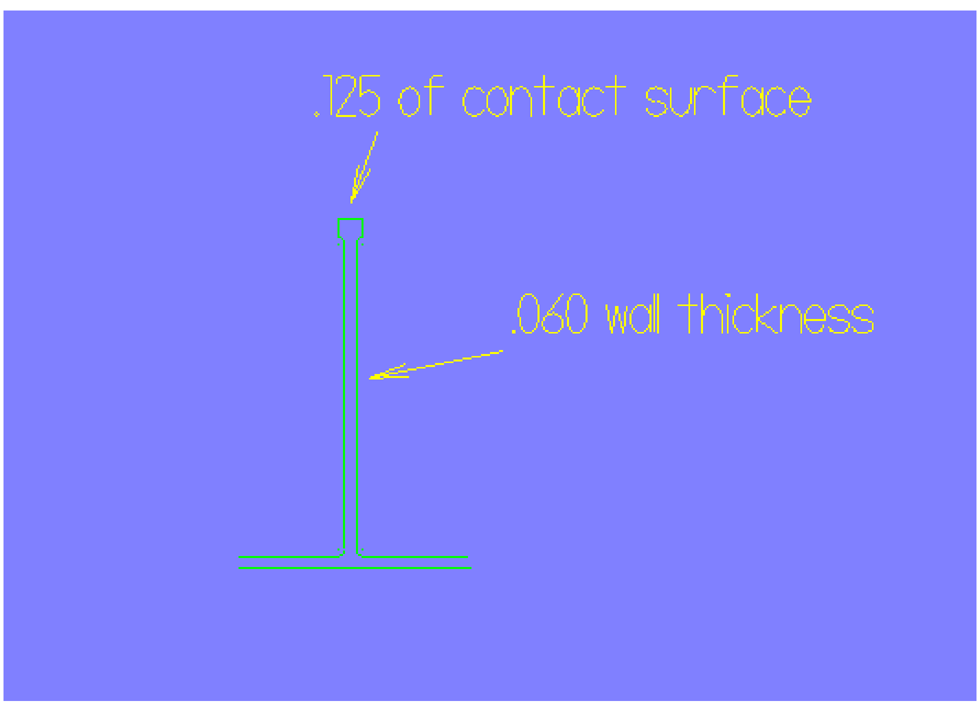

Figure #1, Improved Design

Based on the size of the UH-60Q platform, a team decision was made to perform a “Proof-of-Concept” on a scaled down, single section of the platform. The section would be 7” wide x 12” long x 1.75” thick. The machined area would include two pockets 1.690” deep. The wall and floor thickness would be maintained at .060”, see Figure #2.

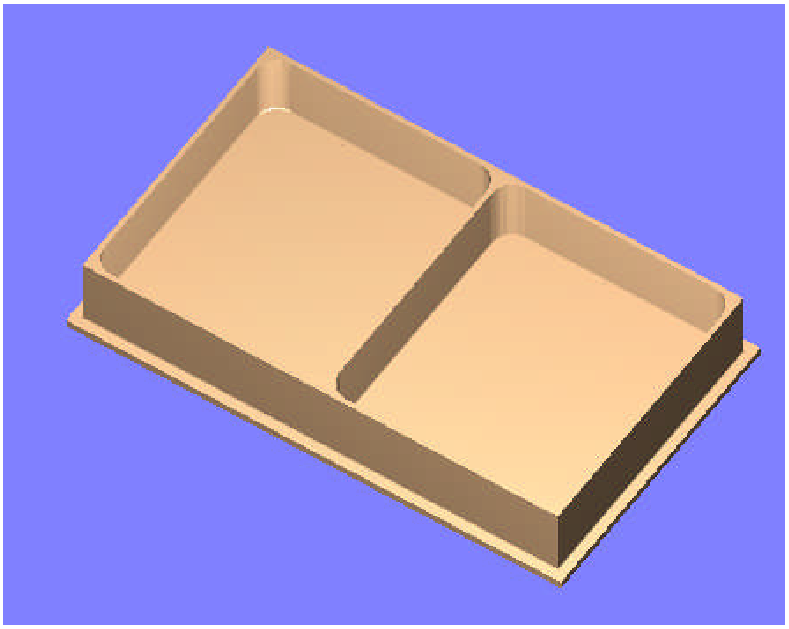

Figure #2, Part Representation

The NCDMM engineers modeled the part using Mastercam software, while developing the tool paths. High Speed Machining (HSM) techniques were used along with thin wall machining techniques. When using HSM techniques, lighter depths of cut (DOC) and faster feeds and speeds are used. HSM requires tool paths that maintain a constant chip load, see Figure #3. Smaller tools are used with high surface feet per minute (SFM). The use of smaller tools helps to reduce the residual stress (generated by the cutting action) from entering the part causing a warp condition.

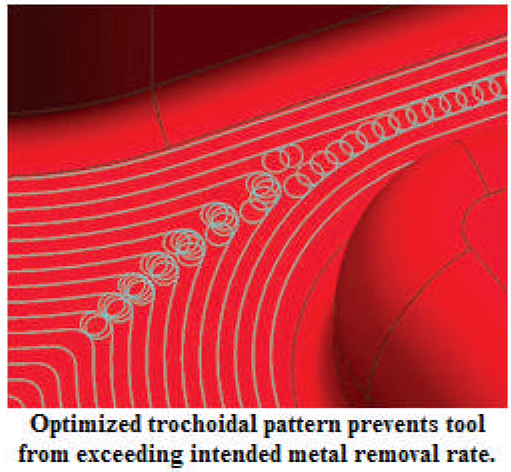

Figure 3, HSM tool path.

Thin wall machining is a technique that is used on walls less than .100" thick. When machining the part, larger roughing stock values are left all around the part. On this particular part it was decided to leave .100" on all surfaces. This extra stock will then be removed during the finish cut. The tool used to thin wall machine is also modified with shank clearance. This clearance is required so that the tool will not rub as it steps down the finished wall, see Figure #4.

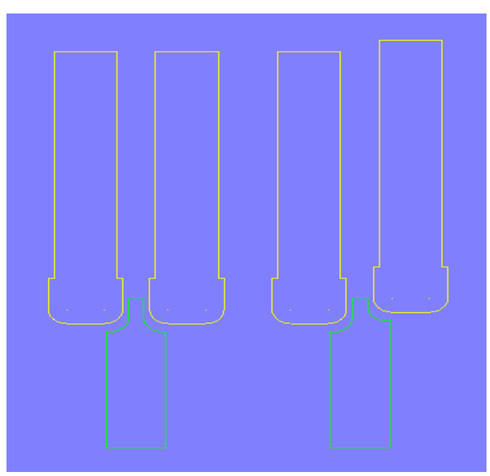

Figure #4, Visual of Thin Wall Machining

The additional stock strengthens the wall at the cutting point, which reduces the amount of push resulting from thin walls.

Using all of these techniques, the NCDMM technicians generated tool paths to rough out the complete part leaving .100" of material on the walls for the finish cut, see Figure #5.

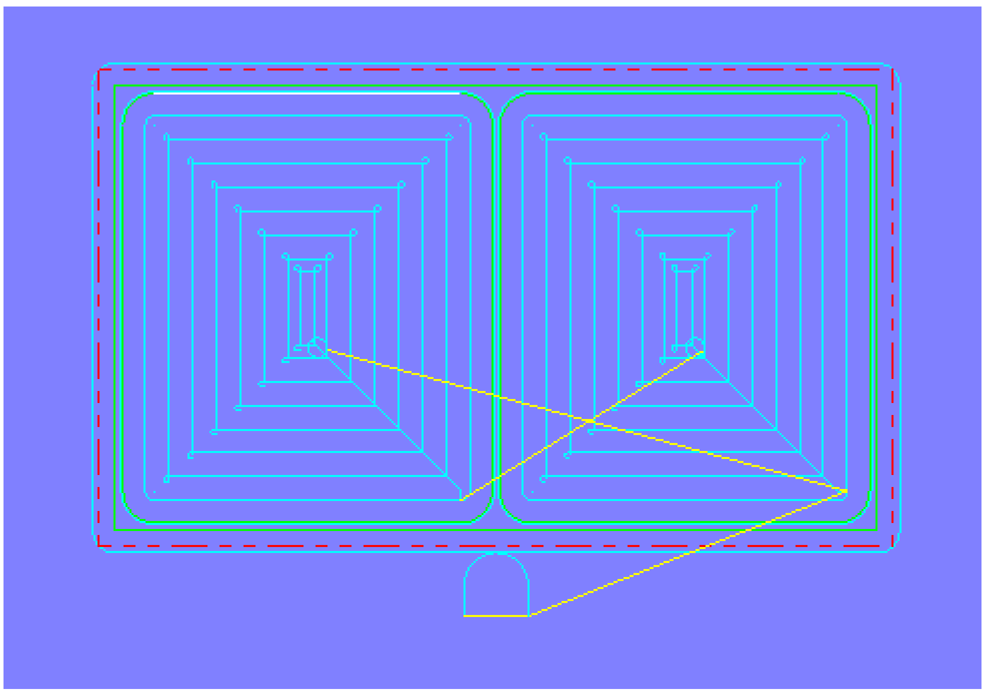

Figure #5, Roughing Tool Path

The selected roughing tool was a .500" diameter, three (3) flute, 37-degree helix end mill. This end mill is a standard Kennametal product and is designed for cutting aluminum. Clearance was ground on the shank to avoid rubbing during deep cutting, see Figure #6 and Figure #7.

Figure #6, Kennametal HPF37A

Figure #7, Shank Relief

The Kennametal HPF37A is a solid carbide end mill grade KC651M. The coating on the end mill is a TiB2, which is an extreamly hard coating that provides very good ware characteristic at high cutting speeds. It reduces edge built up and can help reduce burring. The roughing cycle was preformed at 1200 SFM, which equates to 9168 revolutions per minute (RPM). The axial depth of cut (ADOC) chosen equaled .200" and the radial width of cut (RWOC) chosen equaled 75% of the tool diameter. The feed was preformed at .004 inches per tooth (IPT), which results in 110.0 inches per minute (IPT)

The tool holder chosen for both roughing and finishing was a Kennametal Powergrip milling chuck, see Figure #8.

Figure #8, Powergrip Milling Chuck

The roughing cycle resulted in a 25minute run time. Each pocket along with the out side periphery were roughed complete to the step depth of .200” before moving to next step depth.

Finishing paths were developed in Mastercam software using a custom ground, HPF37A end mill. The tool was ground with a shank relief and the required .032” radius both on top and bottom, see Figure #9. This radius will achieve the required geometry on the top as well as the bottom of the recessed platform wall.

Figure #9, Custom Tool Geometry

The first step in the finishing process was to machine the walls to size. This was completed in .100” axial steps. The axial step depth is determined by the grind on the form tool. It should be noted that this could have been greater, which would result in less run time by reducing the number of passes. The finish cycle was preformed at 1000 SFM, which equates to 7640 RPM. The feed was preformed at .0025” IPT or 57” IPM. The tool path was similar to the roughing where each pocket and the outside periphery were machined complete to a predetermined step depth before moving to next step depth, see Figure #10.

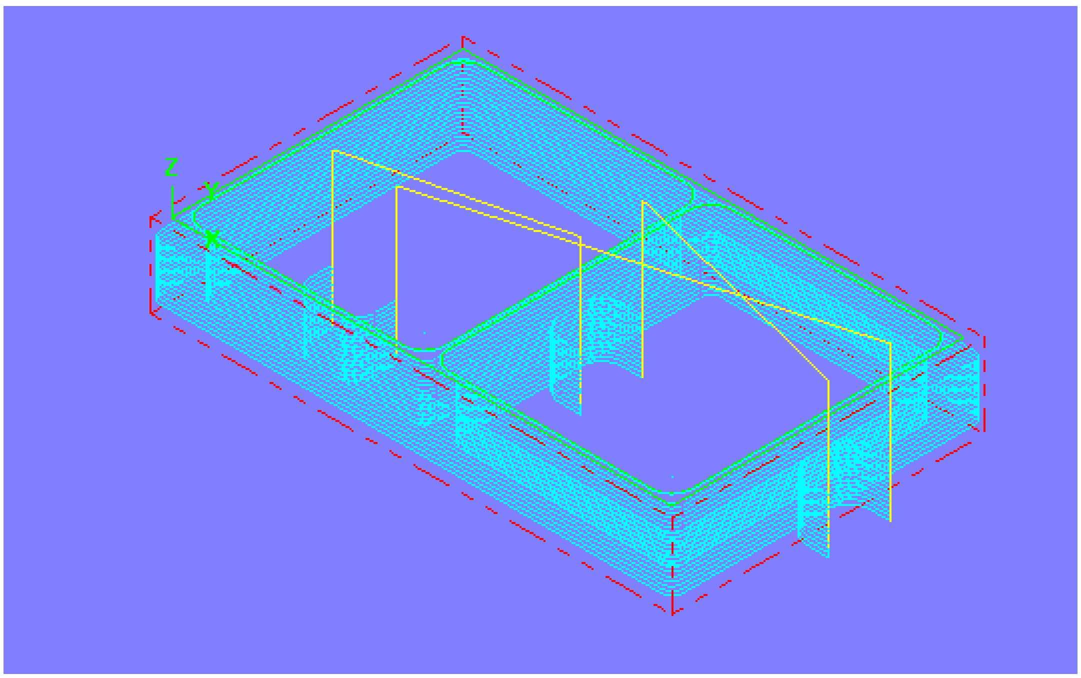

Figure #10, Finish Tool Path

The .100” axial step was repeated to the depth of 1.590”, allowing for the .100” stock on the floor.

The next step in the finishing process required machining the .100” stock from the floor. Using another thin wall technique, this was completed in each pocket resulting in the required .060” floor thickness. The technique requires machining from the center of the pocket outward towards the pocket walls. This method assures that all the machining is taking place at the strongest area on the floor; see Figure #11 and Figure #12.

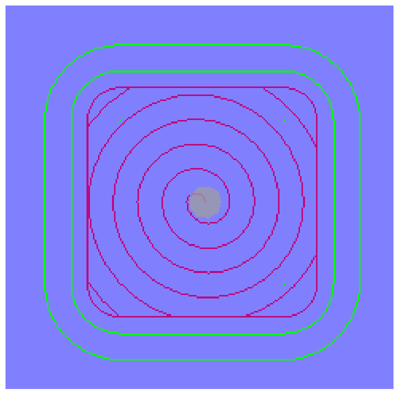

Figure #11, Example of Thin Floor Machining

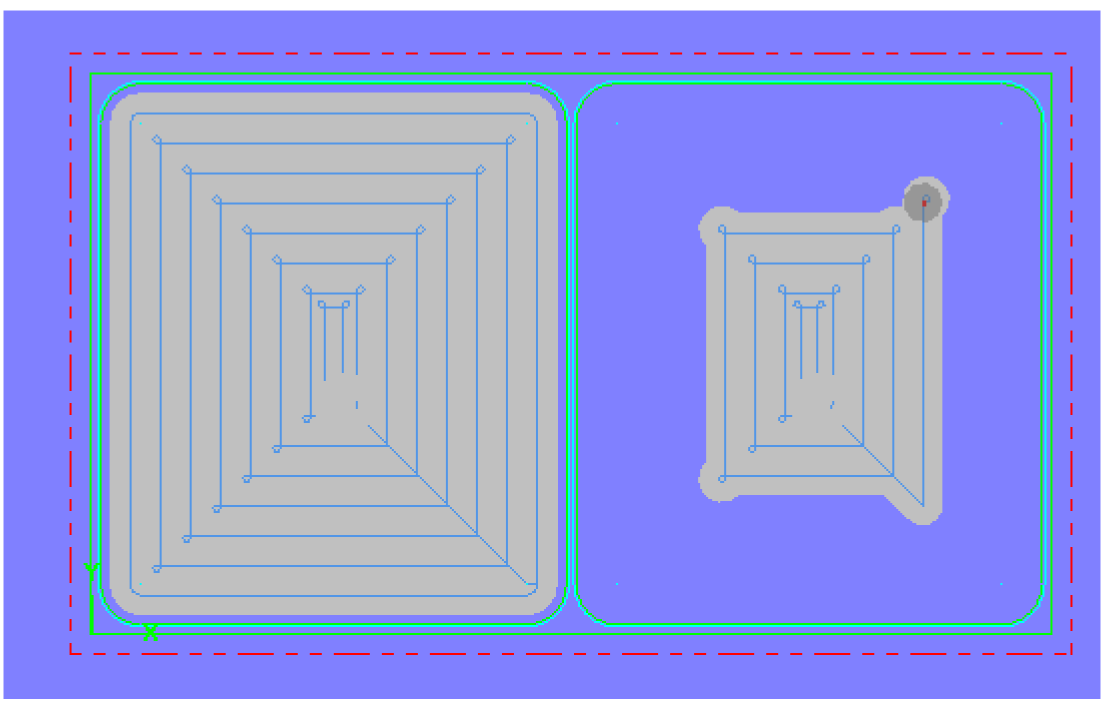

Figure #12, Tool Path for Floor Finish

The floor was then finished to a depth of 1.690”. The floor path blended the floor to the walls with the required .032” radius.

Conclusion

Using state-of-the-market technology and methods described above, the scaled down version of the platform was machined resulting in a total run time of 55 minutes. The NCDMM feels that continuing the testing and tool path refinement, the total run can be further reduced. It is believed that this increased platform surface will satisfy the Army’s demand for the increased “payload” on the UH-60Q MEDEVAC Platform. This new design could potentially reduce the weight of the platform by 30%, in some areas, and also allow for a 50% increase on the contact surface over the old, straight wall design. The “Proof-of-Concept” produced by the NCDMM, from this new design, met all the required geometric part tolerances; see Figure #13 thru Figure #15.

The NCDMM also recommends that several improved platform styles be compared through Finite Element Analysis (FEA). The NCDMM would be able to review any platform styles developed by Air Methods and also provide assistance in that development. The NCDMM would also be able to provide recommendations on any machinability issues that may arise during the machining of the new platform styles.

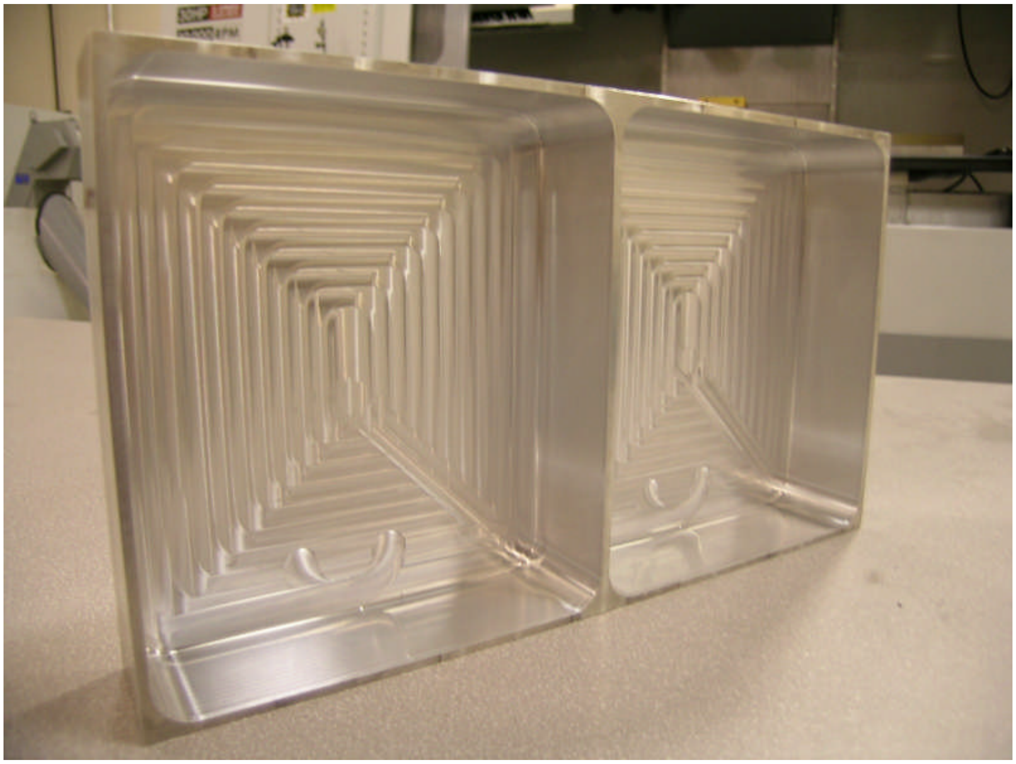

Figure #13, Finished Part

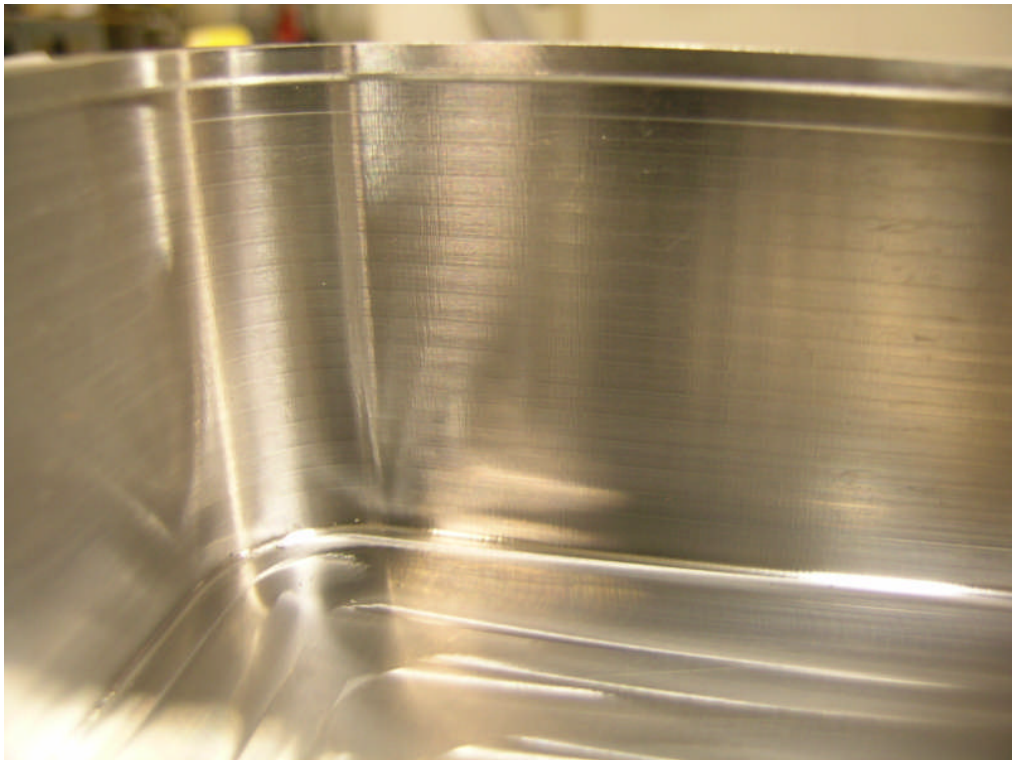

Figure #14, Part Corner & Recessed Wall

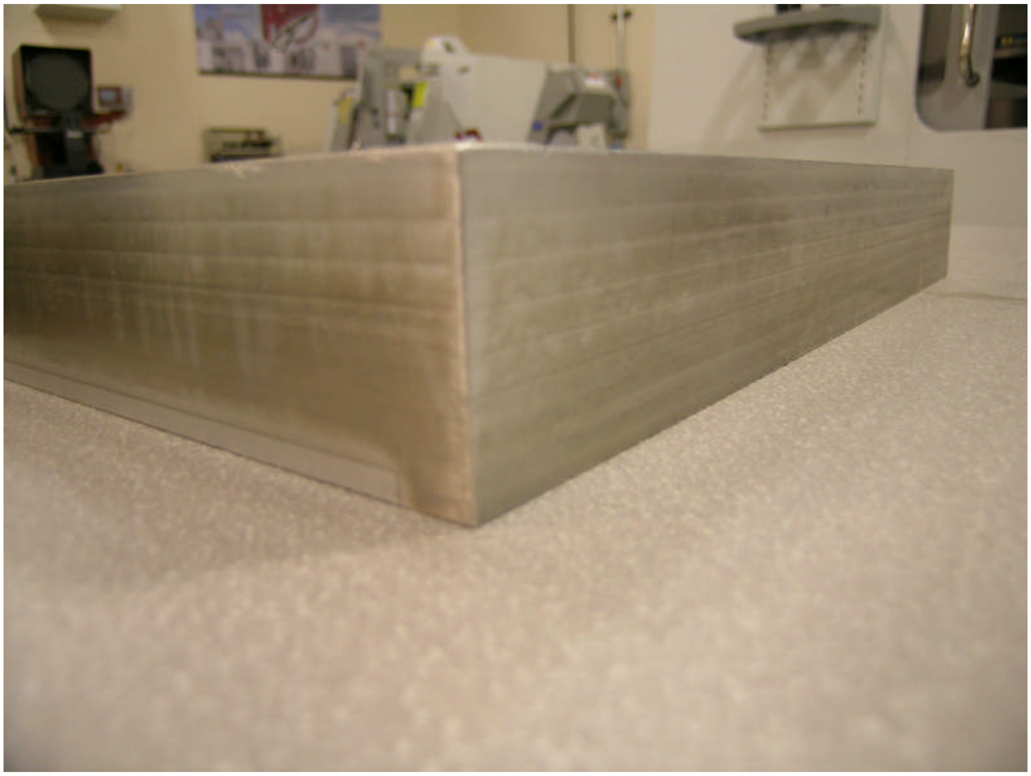

Figure #15, Outside Periphery of Part

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